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SEX: THE MISSING VARIABLE IN HUMAN FACTORS RESEARCH.

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## Sex: The Missing Variable in Human Factors Research

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*During the past 35 years, an ever-increasing number of women has been entering the work force and assuming numerous jobs that were traditionally reserved for men. To see if human factors research has been keeping up with the problems and questions this trend inevitably poses, the content of two leading human factors journals (*Human Factors* and *Ergonomics*) was analyzed for the time period 1965 through 1976. Nearly half the 859 studies examined included only male subjects; only a quarter included females, either exclusively (6%), or with males (19%); and nearly a third gave no indication of the subjects' sex. Even in studies that included both males and females, only a third did analyses to determine whether there were sex differences. The desirability of considering the sex variable in human factors studies and several of the problems associated with doing so are discussed, and recommendations are offered.*

### INTRODUCTION

During the quarter century 1950-1975, the percentage of women in the United States work force has increased at a steady rate of about two percentage points every five years. In 1950 women made up 29% of the work force, and by 1975 the figure was 40% (U. S. Bureau of the Census, 1975). As more women have entered and continue to enter the work force, more of them have chosen traditionally "male" jobs. This appears to be both because of an increased dissatisfaction with traditionally "female" jobs and because the feminist movement has increased the pressure on employers to hire women in nontraditional jobs.

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The pressures to integrate women into non-traditional jobs, and the resulting human factors problems, are particularly prominent in the U.S. Army, which must currently meet its work-force requirements with volunteers, either male or female. Traditionally, military standards (for clothing, performance capabilities, vehicular and other equipment design features, etc.), as well as human engineering guidelines for those outside the military, have been based almost exclusively on data obtained from male-oriented research. The military services are currently initiating efforts to expand the terminology and data base to cover both sexes in their military standards. However, such standard and more generally used reference sources as the *Human Engineering Guide to Equipment Design* (Van Cott and Kinkade, 1972) remain sexually biased and of little use to today's human factors engineer. The human factors

research elements in the Army and the other services clearly need to account for the sex variable in all appropriate research efforts. In responding to this need, it is necessary to consider how the field of human factors is treating the sex variable, as well as the problems that human factors researchers might encounter in incorporating that variable into their studies.

This report presents the results of a survey dealing with the treatment of the sex variable in two leading human factors journals (*Human Factors* and *Ergonomics*) over the 12-year period from 1965 through 1976. It was assumed that works published in these two journals are a fair index of how that variable has been treated in the field as a whole. It was hypothesized that the increasing proportion of women in the workforce would be associated with increasing attention to the sex variable over the time period surveyed. Therefore, 859 original research reports were reviewed to determine the sex of subjects used, the proportion of each sex where both males and females were used, whether or not sex was included as a variable in statistical analyses, and whether or not significant sex differences were obtained. This report also discusses the desirability of including the sex variable in human factors studies, some of the problems associated with doing so, and some recommendations.

#### METHOD

The survey included the most recent 12 complete volumes of *Human Factors* (Volumes 7-18) and *Ergonomics* (Volumes 8-19), covering the years 1965 through 1976. To be considered, an article had to (1) be written in English, (2) report the results of original research, (3) include data from at least two human subjects, (4) include adequate information about subjects, and (5) deal with an area where subjects of either sex could be

used (not, for example, research dealing with menstrual effects on performance). In the specified volumes, 430 articles in *Human Factors*, and 429 in *Ergonomics*, satisfied these criteria. For each article meeting these criteria, the journal, date, author, title, number of subjects, sex ratio, whether or not the sex variable was included in analyses, and whether or not significant sex differences were obtained were recorded. Information about subjects was found in a variety of locations within articles, including the title, the abstract, the *Subjects* section, the general description of the procedure, the written text, or, in some cases, only in statistical tables. A few authors did not describe their subjects in any way, including number; these articles were excluded. Studies which did state the number of subjects, but did not specify sex, were placed in a separate category.

For a descriptive analysis, the resulting list of articles was partitioned into the following categories by sex of the subject population: "Male Subjects Only," "Female Subjects Only," "Unspecified," "Both Sexes Included," and "Both Sexes, Analyzed for Sex Differences." The articles that included both sexes as subjects were also partitioned into three subcategories: "Predominately Males," "Predominately Females," and "Approximately Equal" (defined as neither sex having greater than 55% representation). Additionally, those articles in the "Both Sexes, Analyzed for Sex Differences" category were divided into two further categories: "Significant Sex Differences" and "No Significant Sex Differences."

Tests for chronological trends were conducted for each journal separately, and then for both combined for each of the categories described above. So that each time period would include a meaningful number of articles, the 12-year time span was divided into six two-year periods, then analyzed by a test of "mean-square successive differences" (Dixon and Massey, 1969).

## RESULTS

Table 1 describes the sex composition of the subject populations used in the 859 articles surveyed. Only one trend over the 12-year time period was statistically significant: the percentage of articles in *Human Factors* which included analyses of sex differences showed a fairly steady increase over the period (from 1% in 1965-6 to 8% in 1975-6); but the actual numbers involved are so small that they have little practical significance. Because no trend proved to be both significant *and* meaningful, the data in Table 1 are summarized for the entire period (1965-1976). Furthermore, data for the two journals are combined because the percentages in the various categories were remarkably similar, especially when summed over the entire period.

## DISCUSSION

### *Survey Findings*

The most outstanding finding of the survey of the two human factors journals was the preponderance of male subjects. Nearly half (44%) of all the original research articles used

male subjects exclusively. Even when both sexes were represented (19%), male subjects predominated in over half of these cases. Women were reported as included in only 25% of the studies, and, even in these, they were often in the minority. It is not necessarily surprising that women should be studied so little even at a time when they constitute nearly half the national work force and are rapidly moving into traditionally male jobs. However, these changes would be expected to produce more human factors problems arising from sex differences and should thus lead to more woman-oriented research. Yet, in addition to the overall preponderance of male subjects, there were no significant changes in the male/female ratio of subjects over the 12-year period. Thus, the findings contradict the hypothesis; the increasing proportion of women in the work force was not reflected in more interest in sex as a variable in human factors research.

Another important finding of the survey was that nearly a third of the authors made no attempt to specify the sex of their subjects. It is possible that many of these authors assumed that the readers would know the sex of

TABLE I

Descriptive Analysis of 859 *Human Factors* and *Ergonomics* Articles for Sex Variable Usage from 1965 through 1976

Categories for the period 1965-1976	Combined Values Human Factors and Ergonomics	
	Number	% of Total*
Total Number of Articles Surveyed	859	100
Sex of Subjects Unspecified	264	31
Male Subjects Only	381	44
Female Subjects Only	48	6
Both Sexes Included	166	19
Mostly Male (55%)	85	51 (of 166)
Mostly Female (55%)	20	12 (of 166)
Approximately Equal	61	37 (of 166)
Sex Variable Considered in Analysis	59	7
Significant Sex Differences Found	43	73 (of 59)

\* Unless otherwise noted.

their subjects from a description of their occupations or from the general tone of the article. However, as women become involved in more nontraditional occupations, as is especially true within the military community, it is becoming more difficult for journal readers to make inferences and justify such assumptions. It may be concluded then that failing to specify sex and sex ratios is not only a poor professional practice, but an increasingly confusing one as well.

The survey also revealed that only slightly more than a third of the 166 studies including both sexes as subjects (and only 7% of the total 859 studies) reported considering the sex variable in analyzing their data. It is highly probable that this practice ignores important information, because 73% of the studies which evaluated the sex variable statistically found significant sex differences. It is possible that studies do not report analyses for sex differences because the results did not yield any differences; because of a pre-analysis assumption that there are no differences, possibly based on prior data; because of failure to use statistical procedures which could evaluate the sex variable; because poor sampling procedures (i.e., including only one or two female subjects as compared with a much greater number of male subjects) precluded meaningful statistical comparisons; or because results obtained were uninterpretable or unrepeatable. Regardless of their reasons, nearly two-thirds of the authors of articles surveyed chose to leave their readers wondering whether important information was needlessly ignored, or whether the experimenter used poor procedures or bad judgment, or possibly whether there were good reasons for not considering the sex variable.

Because of the dramatic similarity between the ways the two journals surveyed treated the sex variable, the conclusions and recommendations given here apply equally to both

journals. This similarity also suggests that both journals reflect the same general attitude toward treatment of the sex variable, and it may indicate that they reflect the prevailing attitude within the entire human factors community.

#### *Problems in Treating the Sex Variable*

The reasons for ignoring the sex variable are probably as varied as the research topics included in the human factors field. But most human factors researchers share some problems, such as the limited availability of subjects and the additional time, dollars, and personnel needed to run larger studies which would include the sex variable.

However, several factors are either unique to the treatment of the sex variable or are at least exaggerated by including it in human factors research. Among such factors are the following:

- (1) *Sensitivity of topics investigated or information derived.* The Privacy Act of 1974 (U.S. Public Law 93-579) requires complete disclosure to the subjects of methods, dangers, and information to be obtained, in all studies. In studies comparing male and female performance abilities, motivation could be profoundly influenced. Joscelyn (1976) has discussed the legal implications of the Privacy Act for human factors research.
- (2) *Publicity.* Current public attention to the feminist movement, the Equal Rights Amendment, the movement of women into the Armed Forces, etc., has brought the media to the doorstep of many researchers dealing with the sex variable. Even without the danger of adverse publicity or distortion, such attention during or before a study can have harmful effects by affecting subjects' and researchers' motivation.
- (3) *Prejudices.* The preconceived notions of the relative abilities of men and women, held by either the experimenters or the subjects, can have strong influences on the results of sex-differences research.
- (4) *Pressures.* Pressures from granting agencies, special interest groups, and superiors are quite common in this area. Pressures to find differences in one direction or another, to prove no differences exist at all, or to answer

complex questions in a quick simple study, all influence the researcher attempting to study the sex variable.

- (5) *Complexity of the problem.* Most human factors investigators are probably aware of the complex nature of studying sex differences, but many do not have the specific knowledge or resources to deal with the problem properly. For instance, it is commonly accepted that a woman's menstrual cycle has some effect on behavior, but few human factors researchers have adequate training in endocrinology to deal with hormonal factors properly, and even fewer have access to the facilities required.
- (6) *Social factors.* There are many aspects to this general problem. The experiential histories of the subjects can have profound effects; hence it is extremely important to sample properly the population to which one wishes to generalize. Volunteer subjects can provide quite different results than nonvolunteers. Doty and Silverthorne (1975) found that women had a strong tendency not to volunteer as experimental subjects during the menstrual phase of their cycles. A biased sample, excluding menstruating women, could lead to misinformation about women's performance on tasks affected by hormone variation. The dynamic nature of social influences on behavior (i.e., changing sex roles) means that today's experimental findings and conclusions might well be invalid for a new generation growing up under different conditions.

#### Recommendations

The preceding list of problems in treating the sex variable strongly suggests that not every human factors study or human factors researcher should or can always examine that variable. There are, however, several ways all researchers can help those who can more properly give it their attention.

- (1) It is most important that each report include a complete description of its subject sample. Sex, age, and ratio of males to females should be specified for each group.
- (2) A relatively small ratio of females to males is often included in a study arbitrarily, with no intention of testing the sex variable. Unfortunately, it generally contributes to the error of measurement and often precludes the use of statistical tests on the sex variable. Therefore,

it is best to avoid this practice altogether. When adequate numbers of subjects of both sexes are not available, the use of subjects of only one sex, even if in lesser numbers, will generally yield more reliable and more easily interpretable results.

- (3) In studies where both sexes are included and valid statistical tests of sex differences can be applied, such tests should be done and reported, even where no differences are found.
- (4) Studies involving female subjects should, ideally, either include "phase of menstrual cycle" as a variable, or attempt to control for possible variation between phases in other ways (e.g., select subjects in one particular phase). Since oral contraceptives affect hormone levels, their use or non-use should be treated or controlled for as well.

#### CONCLUSIONS

Only a small percentage of present day human factors research is done with women, even less recognizes the sex variable as a factor, and there is no trend toward change of the situation. Nevertheless, as more organizations become truly committed to placing women in nontraditional jobs, more human factors researchers should begin to examine sex as a performance variable. It is also hoped that this paper will make investigators and editors in the field more aware of the deficiencies in a large proportion of the published human factors research, and that they, in turn, will seek in the future to provide more and better information on the sex variable.

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